

# Experiments: Anomalies and open issues of the MICROSCOPE Space Test of the Weak Equivalence Principle

MICROSCOPE's final results report no violation of the Weak Equivalence Principle (Universality of Free Fall) for Pt and Ti test masses quantified by an Eötvös parameter  $\eta \sim 10^{-15}$ , an improvement by about two orders of magnitude over the best ground tests. The measurement is limited by random noise with  $1/\sqrt{f}$  frequency dependence attributed to thermal noise from internal damping occurring in the grounding wires. From information available and the physics of internal damping we calculate the differential acceleration noise spectral density at the signal frequency, and show it varies widely between experiment sessions. Such large variations are inexplicable if translated into physical quantities such as the quality factor. While calibrations interspersed with measurement sessions may cause some such changes, they cannot explain jumps between consecutive sessions without recalibration. A potential explanation is conjectured related to a fluctuating zero depending on measurement initialization errors. The experiment was severely affected by "glitches"—anomalous acceleration spikes related to radiation from the Earth—injecting significant power at the signal frequency and its harmonics. The procedure used to deal with the glitches depends on introducing artificial data and leaves spurious effects potentially mimicking a violation signal or canceling a real one. An alternative procedure, relying only on real measured data, is proposed, already used in ground tests of the Weak Equivalence Principle by the Eöt-Wash group. Future experiments aiming to exploit the full potential of space must resolve these issues, rely solely on measured data, and, more generally, readdress the experiment design.

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